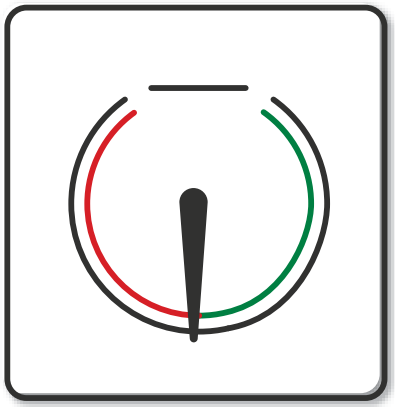
Automation
Control
Engineering

Automation of Inland Navigation to Increase Safety and Energy Efficiency

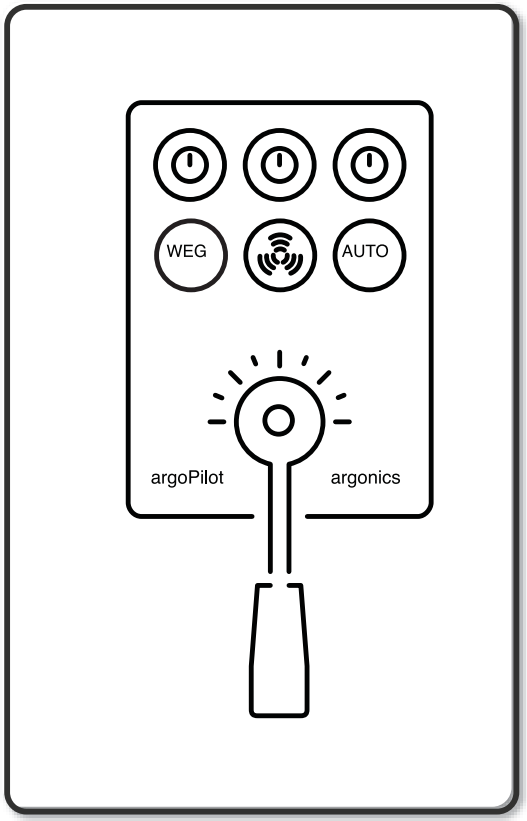
Dr.-Ing. Alexander Lutz
Budapest, 29th Sept 2020
argonics GmbH

Navigation on Inland Waterways – Current State

Follow-up mode



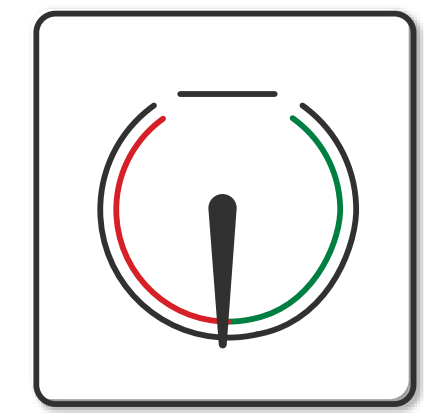
Rudder angle



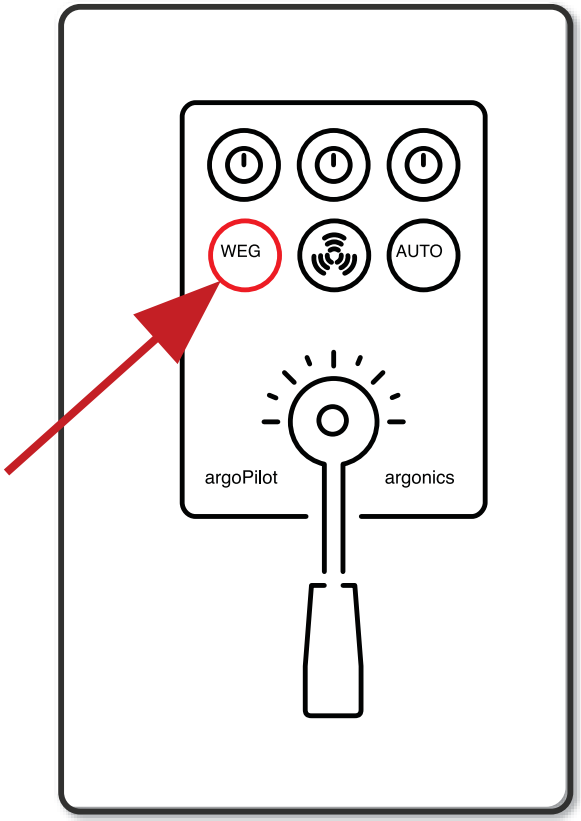
Navigation on Inland Waterways – Current State

Follow-up mode

Setpoint: Rudder angle



Rudder angle



Navigation on Inland Waterways – Current State

Follow-up mode

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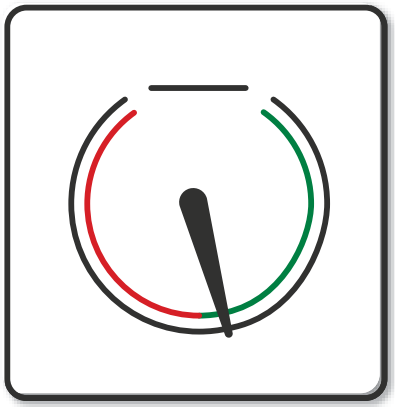
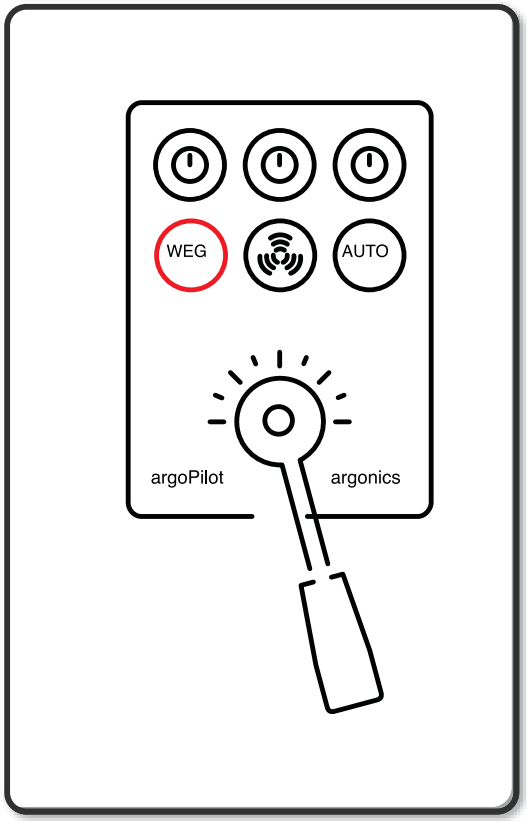


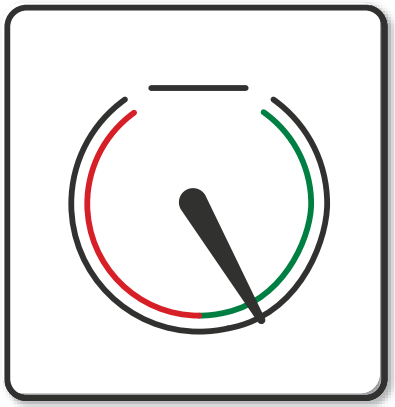
Rudder angle



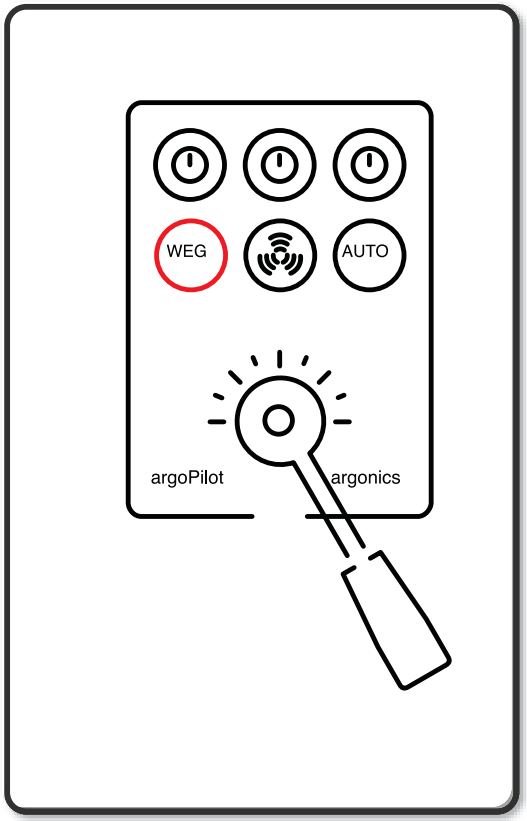
Navigation on Inland Waterways – Current State

Follow-up mode

Setpoint: Rudder angle



Rudder angle



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Follow-up mode

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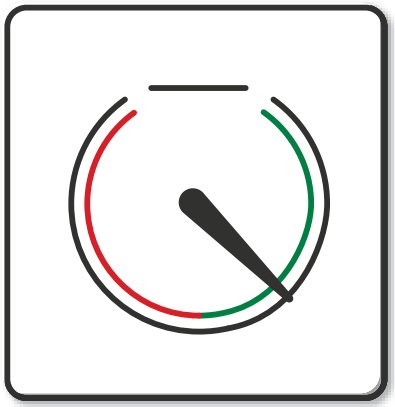

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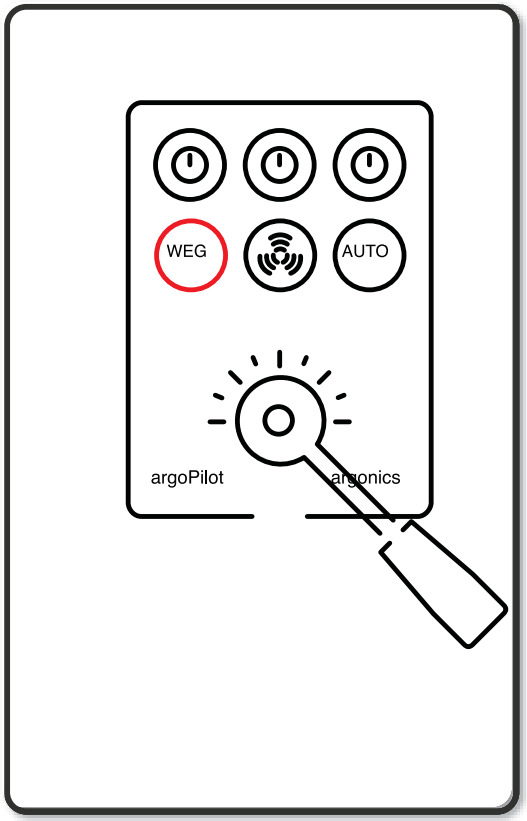
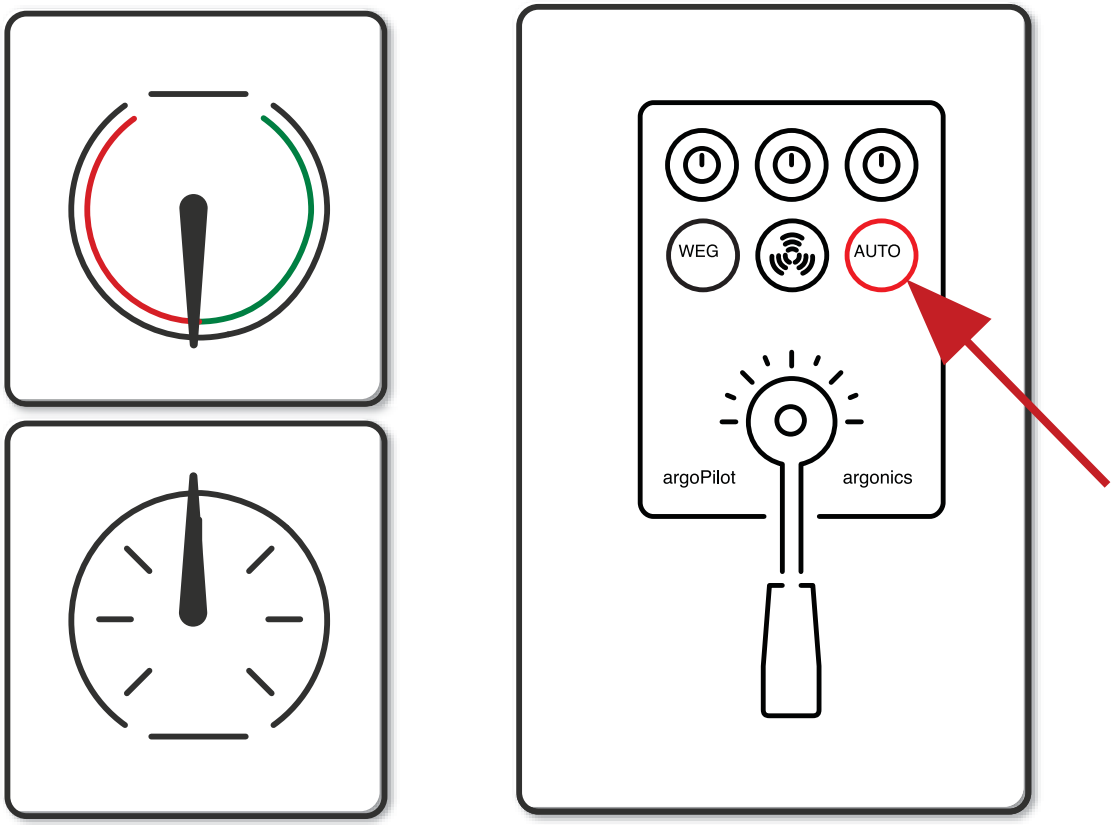


Navigation on Inland Waterways – Current State

Auto mode

Setpoint: Rate of turn

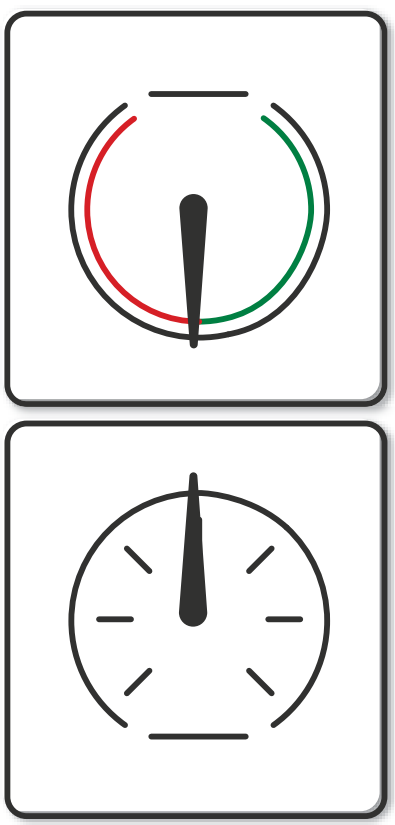


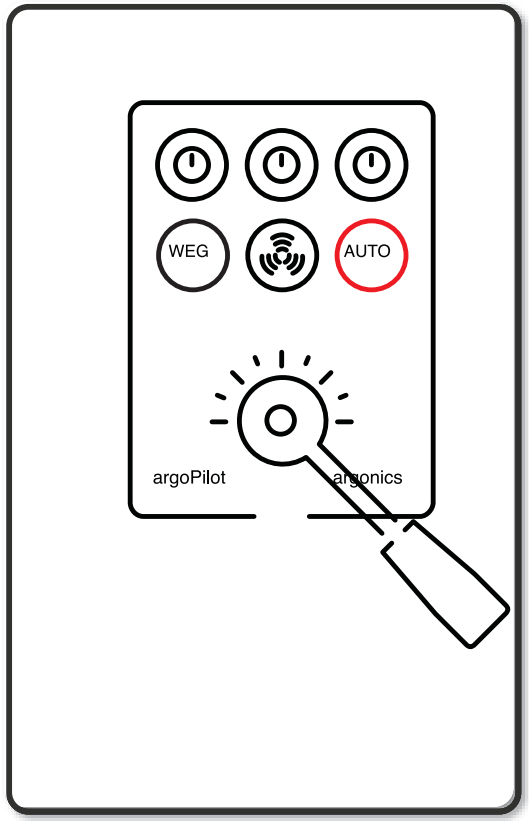
Rate of turn

Navigation on Inland Waterways – Current State

Auto mode

Setpoint: Rate of turn



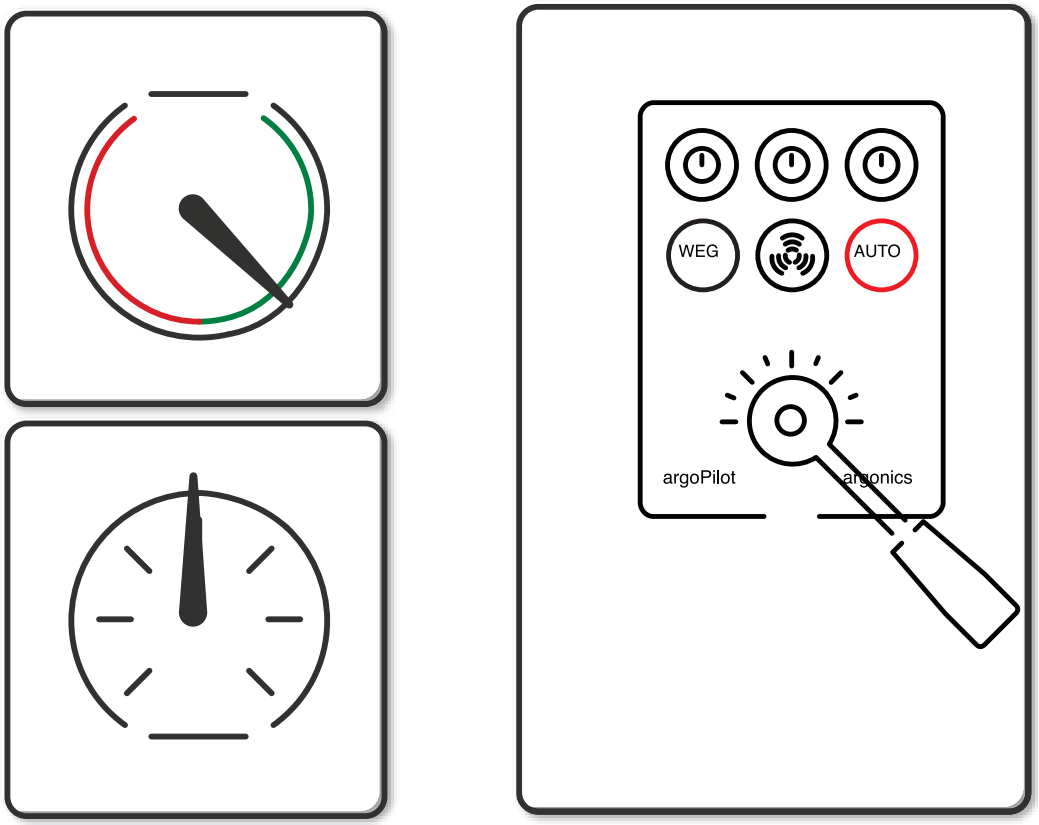


Rate of turn

Navigation on Inland Waterways – Current State

Auto mode

Setpoint: Rate of turn



Rate of turn

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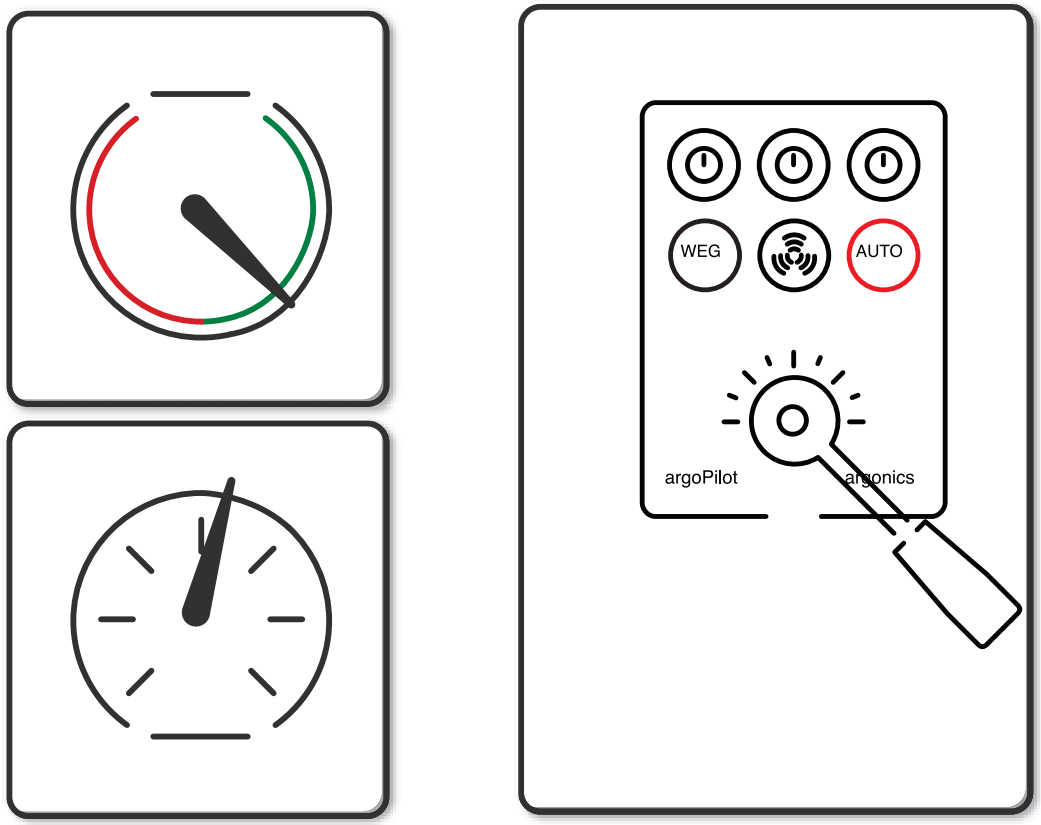

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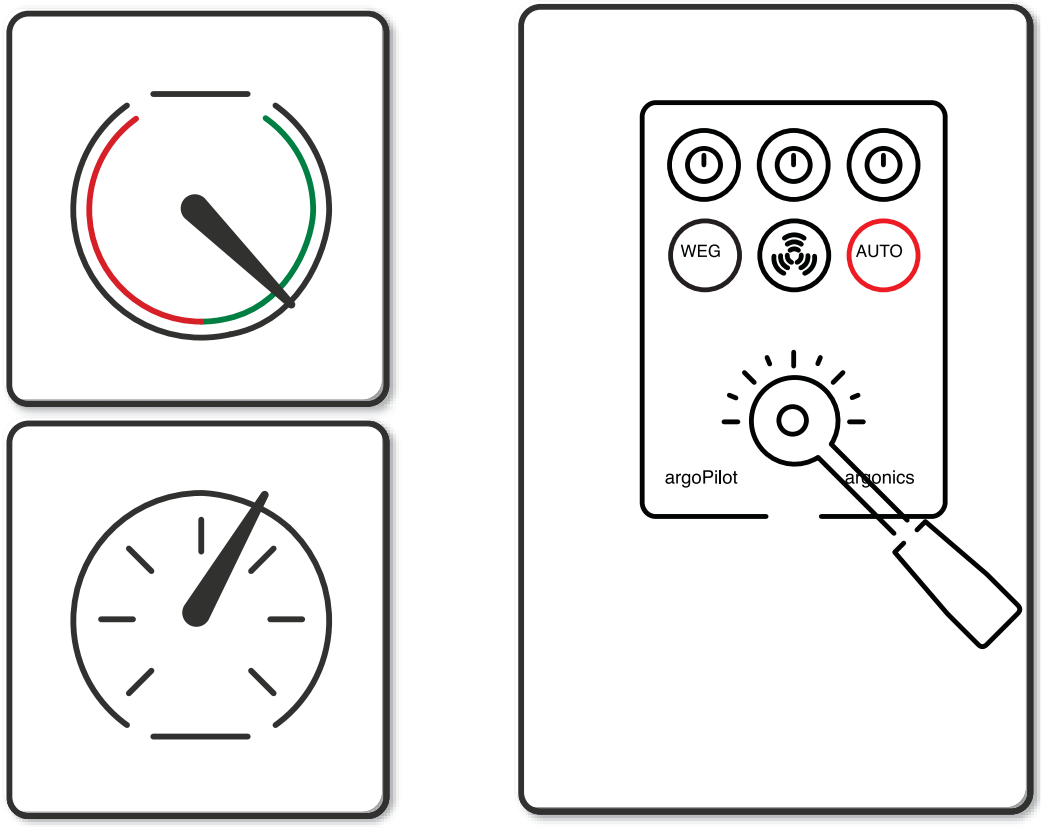

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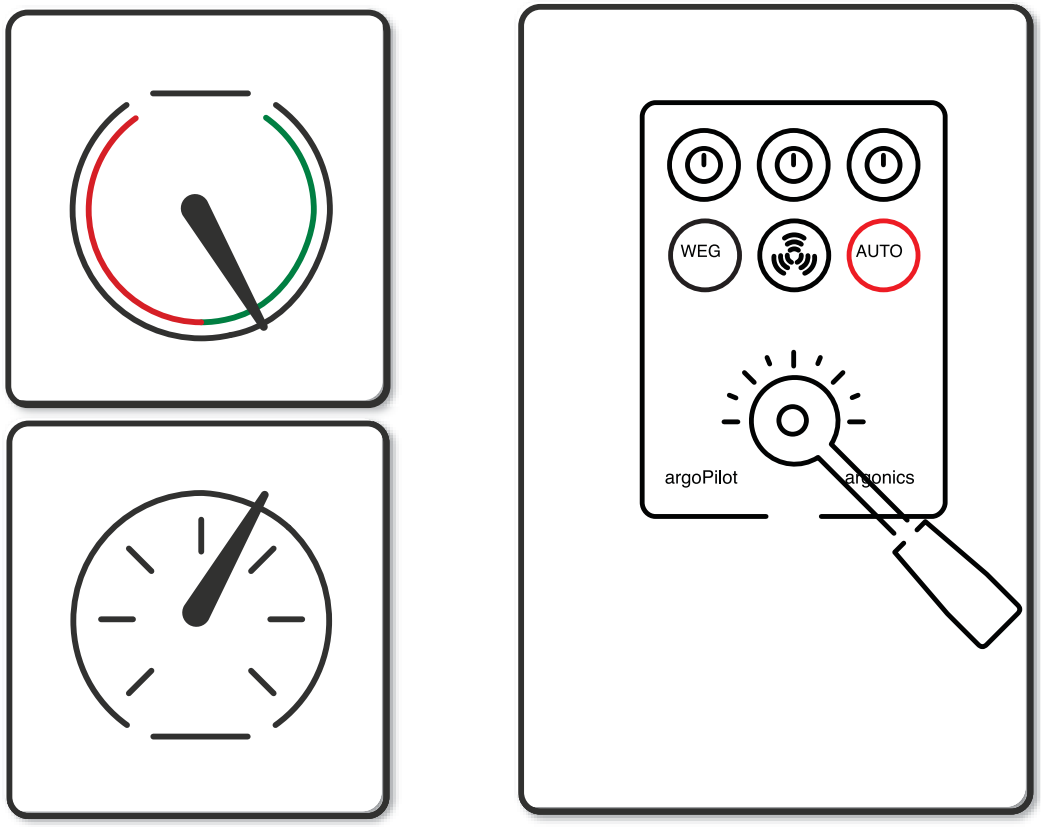

Rate of turn

Navigation on Inland Waterways – Current State

Auto mode

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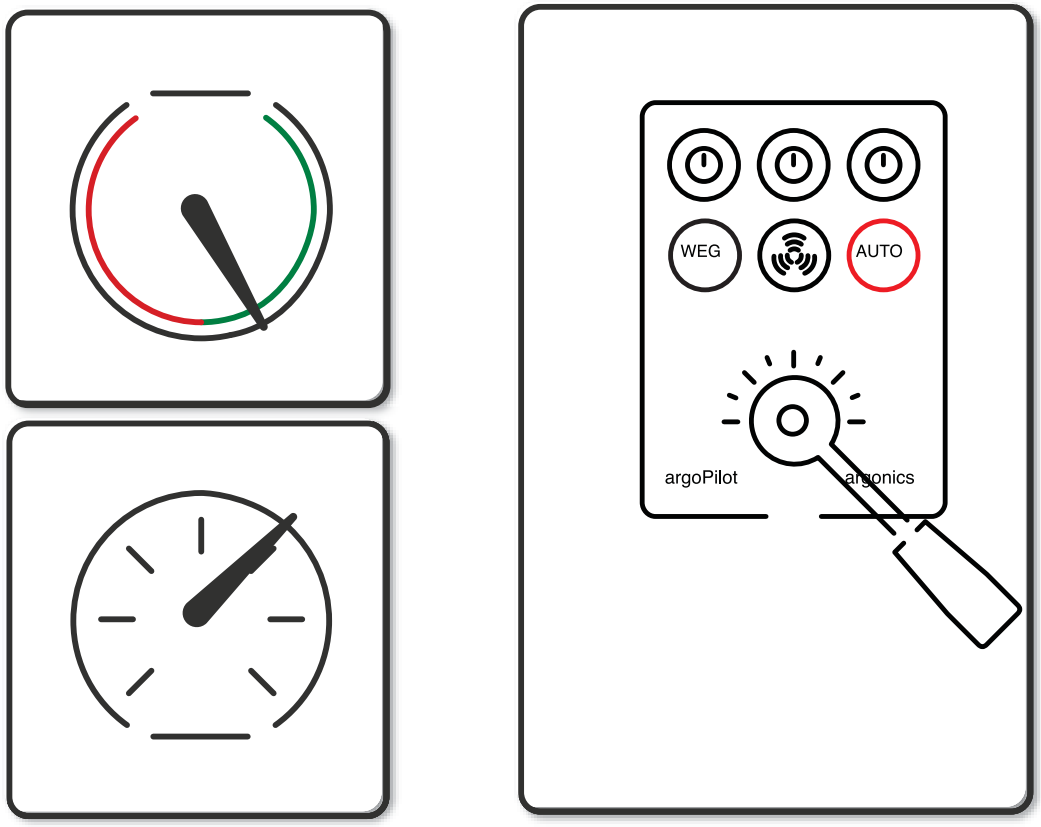
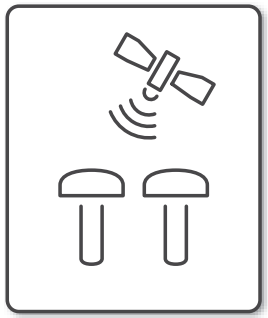


Rate of turn

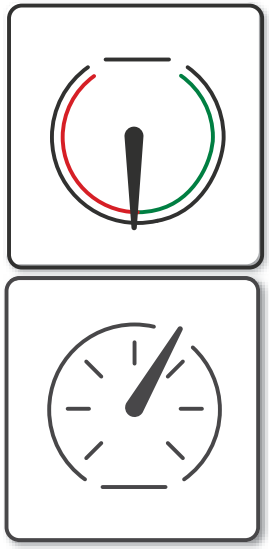
Navigation on Inland Waterways – Existing Future

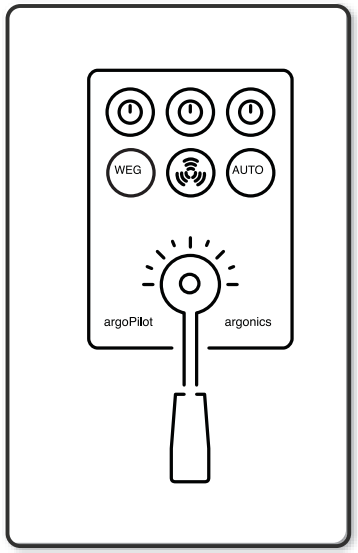
Automatic Track-keeping

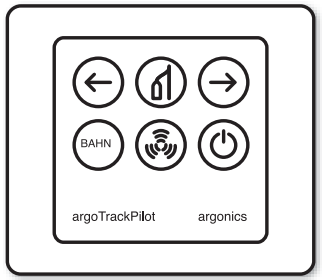
Setpoint: Track (guiding line)



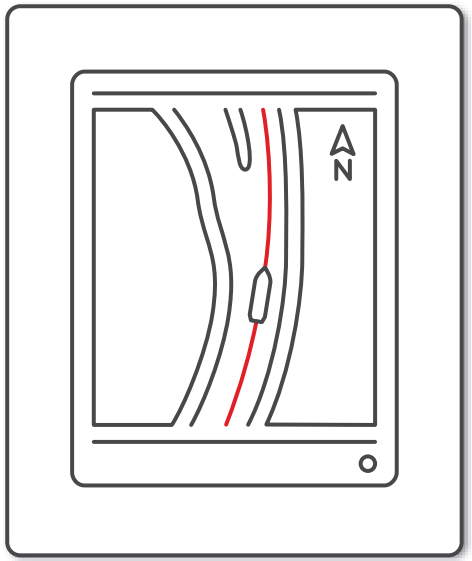
GNSS compass







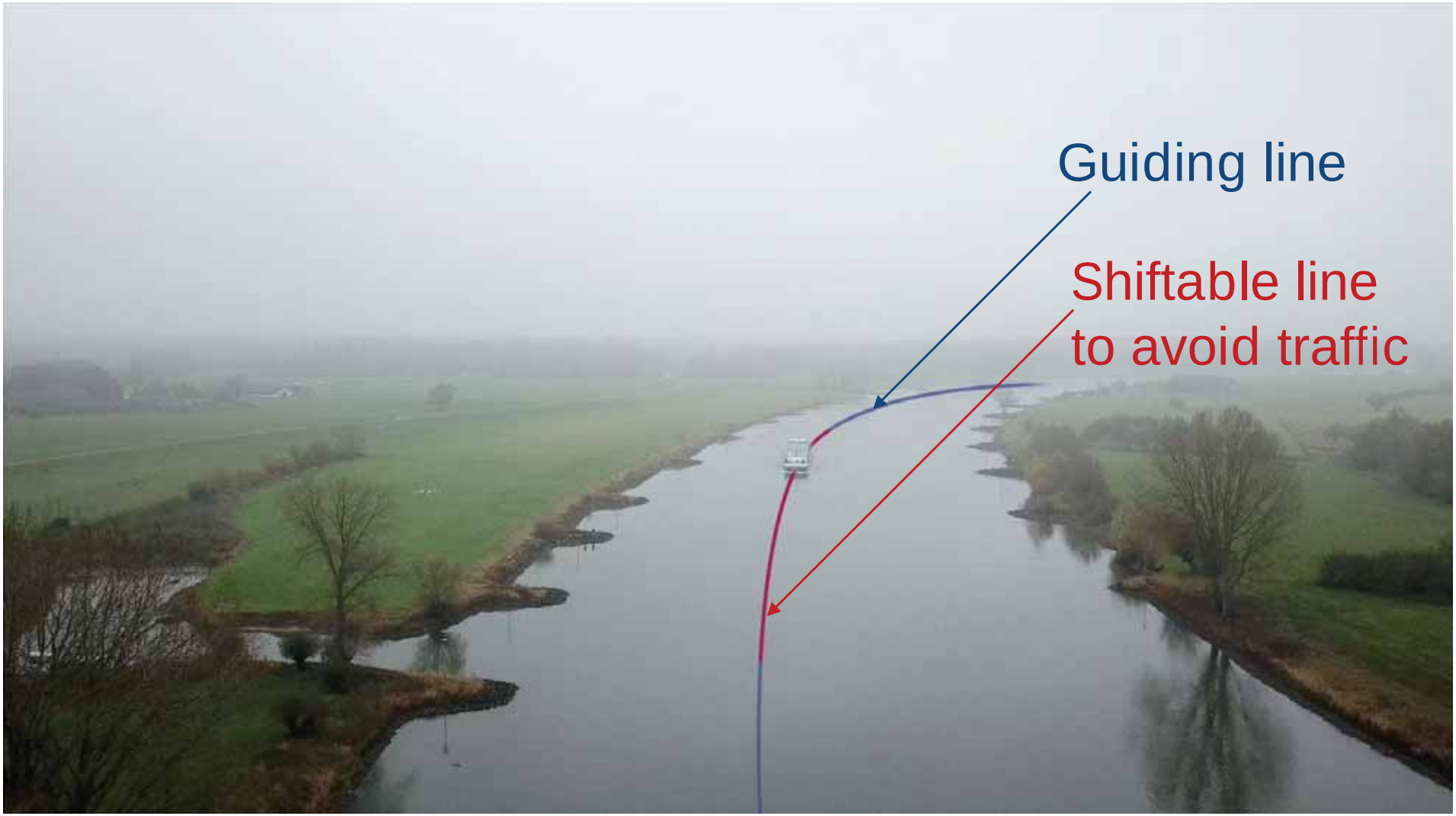
argoTrackPilot



Inland ECDIS

Navigation on Inland Waterways – Existing Future

Automatic Track-keeping



Navigation on Inland Waterways – Existing Future

Automatic Track-keeping

argoTrackPilot

Traffic avoidance

Video: Please load external file

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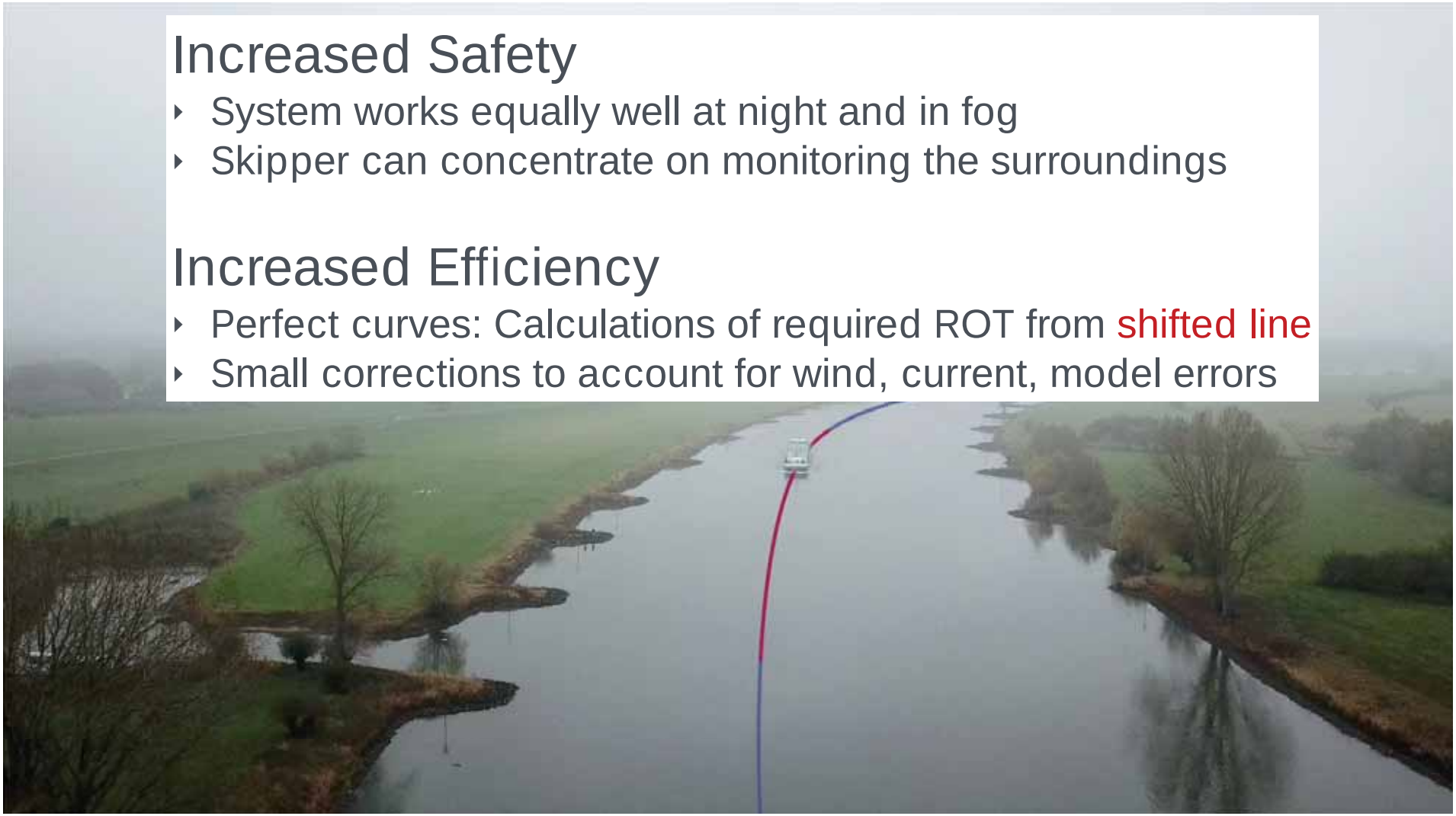
Navigation on Inland Waterways – Existing Future

Automatic Track-keeping



Navigation on Inland Waterways – Existing Future

Automatic Track-keeping

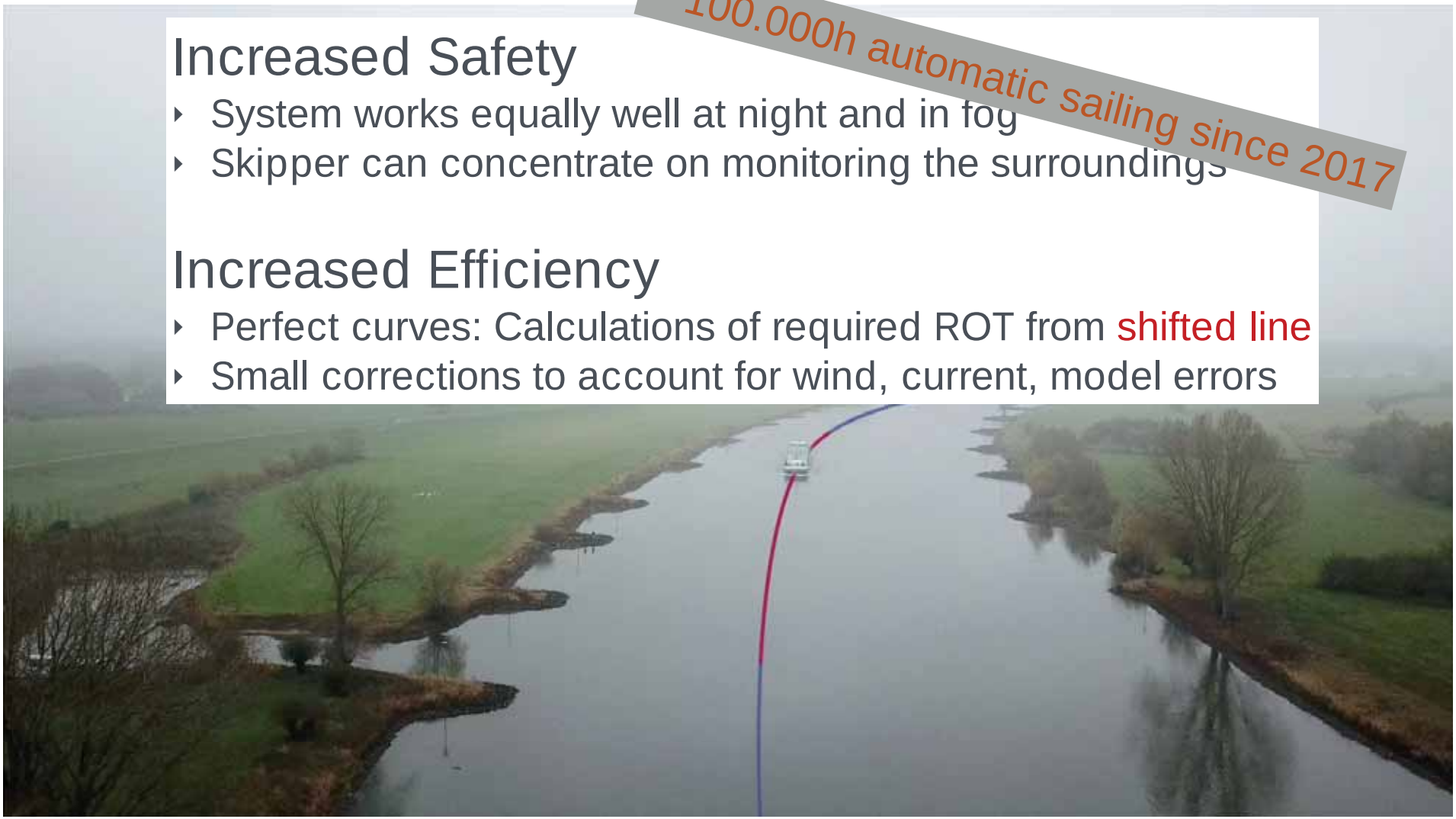
> 100.000h automatic sailing since 2017

Increased Safety

- System works equally well at night and in fog
- Skipper can concentrate on monitoring the surroundings

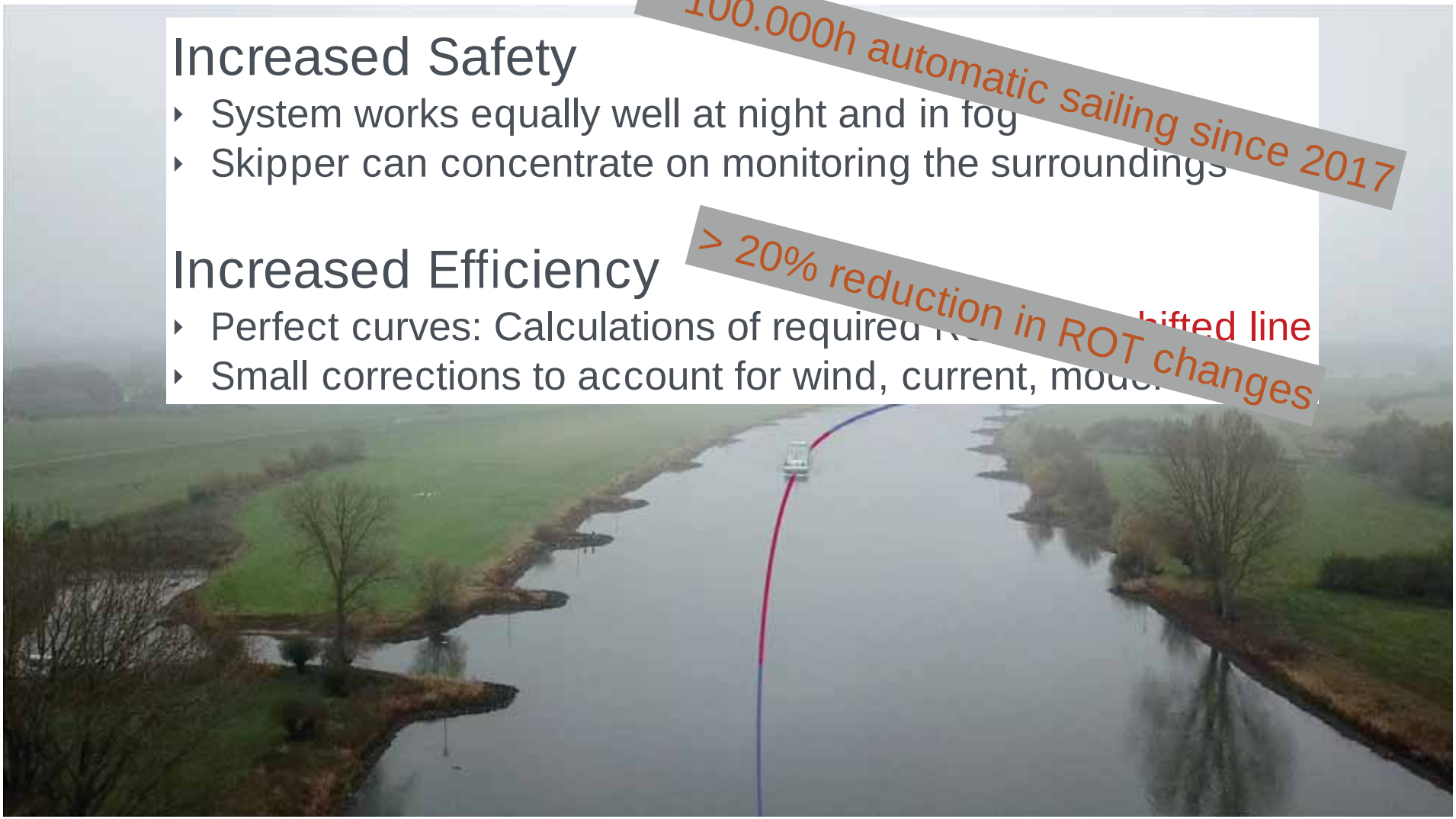
Increased Efficiency

- Perfect curves: Calculations of required ROT from shifted line
- Small corrections to account for wind, current, model errors



Navigation on Inland Waterways – Existing Future

Automatic Track-keeping



Navigation on Inland Waterways – Existing Future

Automatic Track-keeping

135m

Installations on many different types of vessels

135m

186m

186m

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Navigation on Inland Waterways – Existing Future

Automatic Track-keeping

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argoTrackPilot

ALPHATRON

AlphaRiverTrackPilot

Navigation on Inland Waterways – Existing Future

Automatic Track-keeping

100 units sold since November 2017

argonics

argoTrackPilot

ALPHATRON

AlphaRiverTrackPilot

MS Rosarium

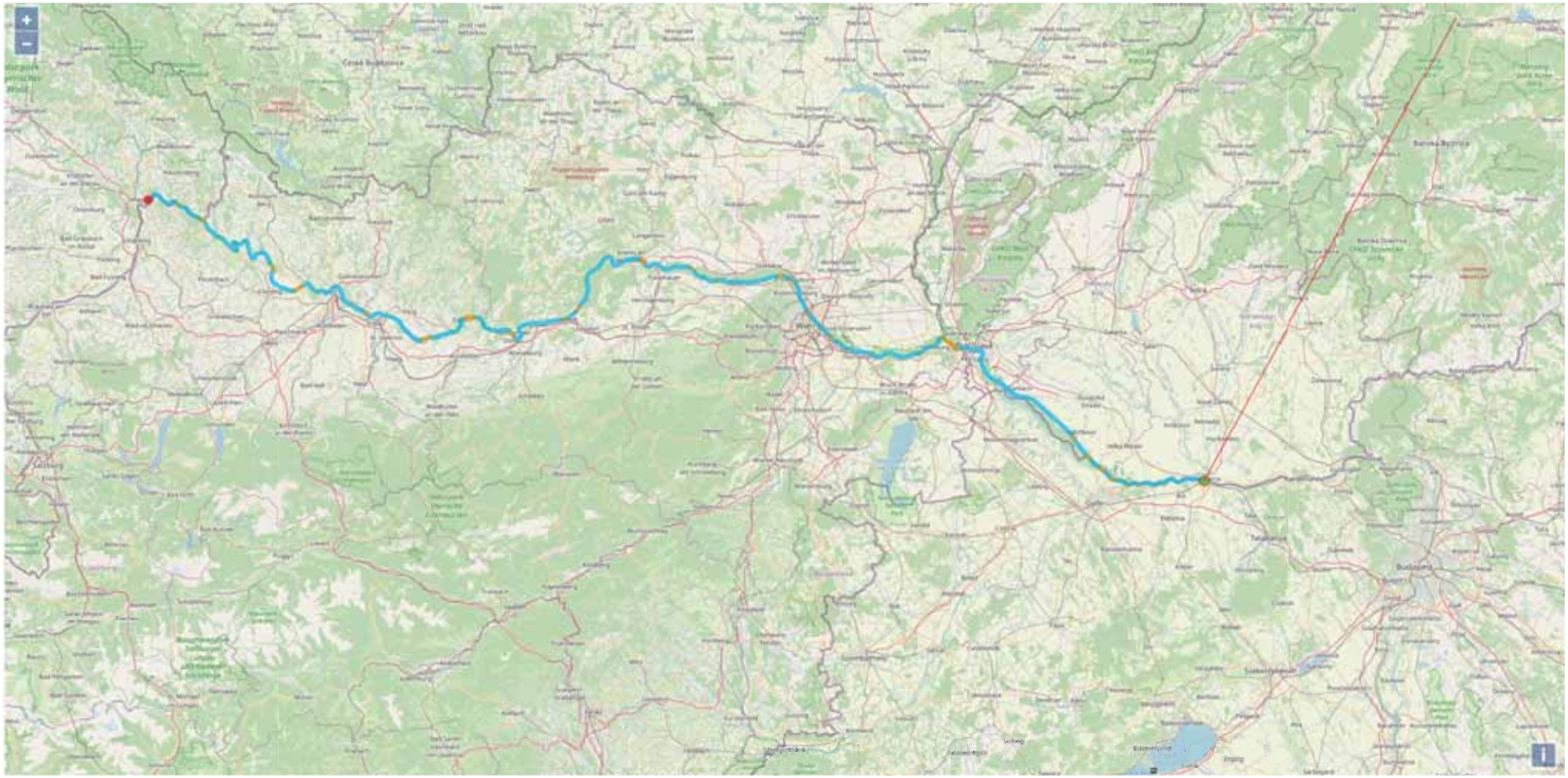
135m x 11,45m

argoTrackPilot

Komorn → Passau

45 hours 20 minutes

MS Rosarium



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argoTrackPilot

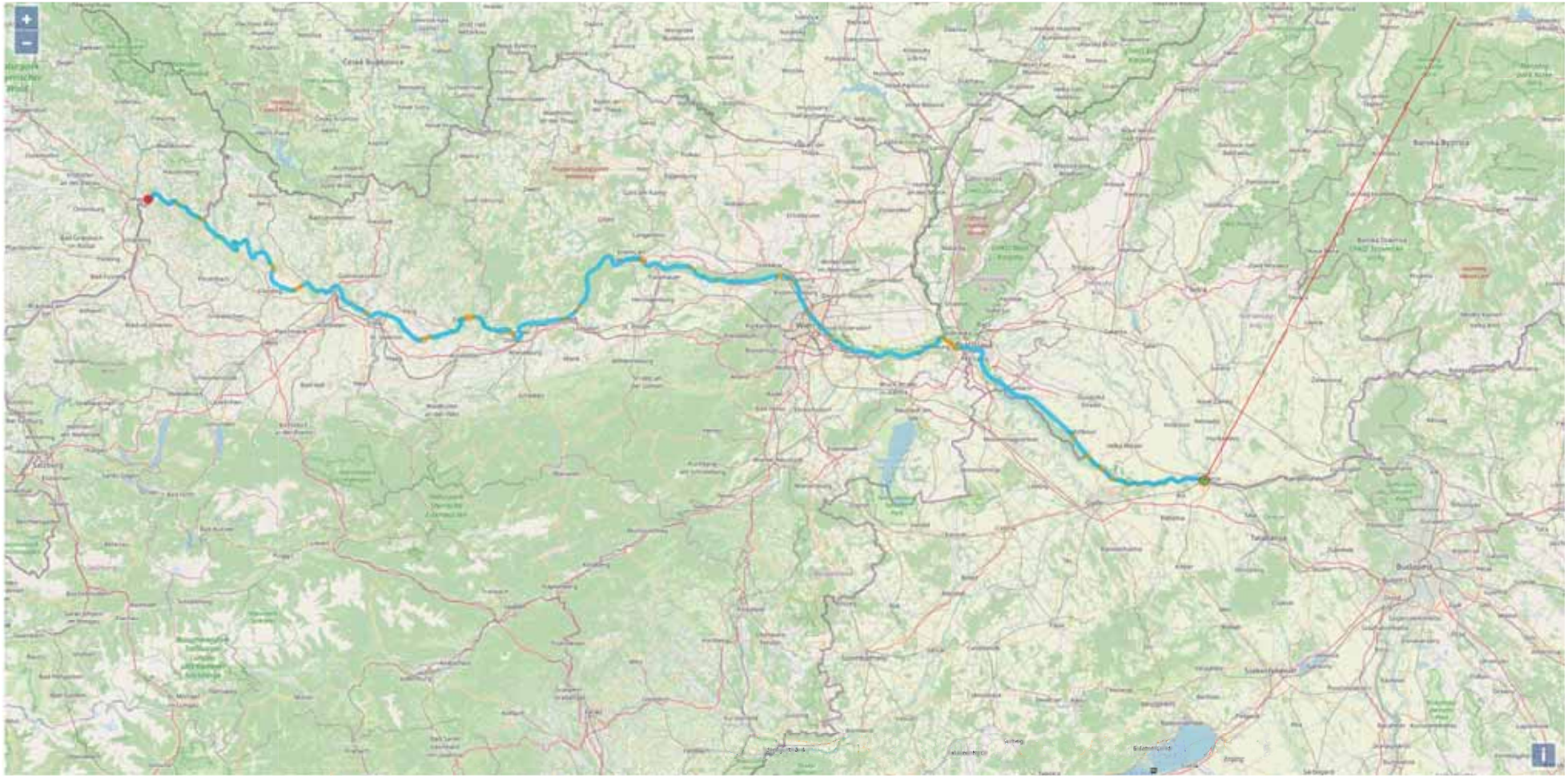
Komorn → Passau

45 hours 20 minutes

90.5 % navigating automatically

standard deviation from track: 2.6 m

MS Rosarium



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MS Feniks

110m x 11,40m

argoTrackPilot

Amsterdam → Rotterdam

8 hours 20 minutes

MS Feniks

argonics GmbH

argoTrackPilot

Amsterdam → Rotterdam

8 hours 20 minutes

91 % of the time navigating automatically

standard deviation: canal 1.2 m ; river 2.6 m

MS Feniks

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KV El Niño + La Niña

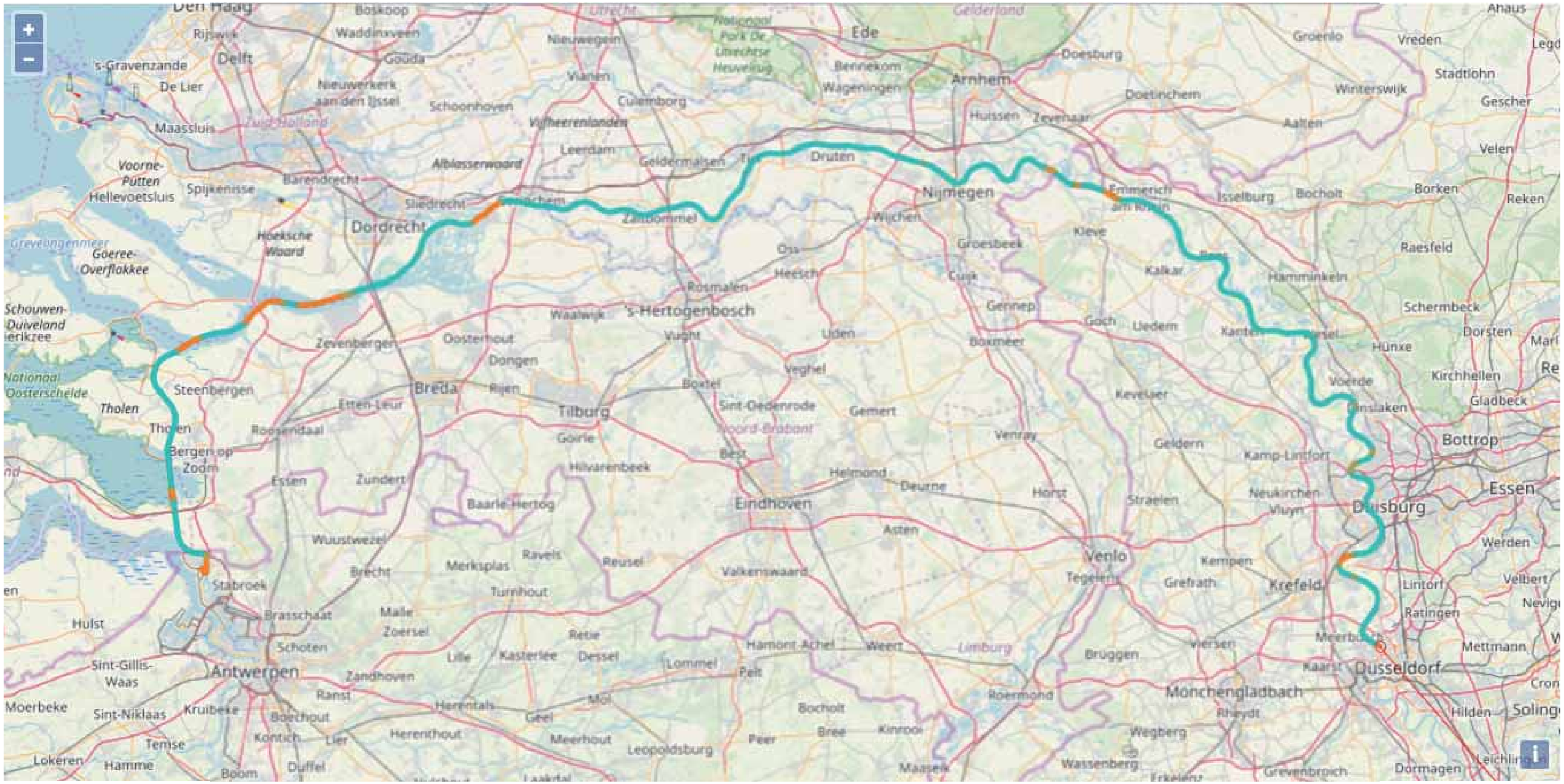
186m x 11,40m

argoTrackPilot

Düsseldorf → Antwerp

22 hours 51 minutes

KV El Niño + La Niña



argoTrackPilot

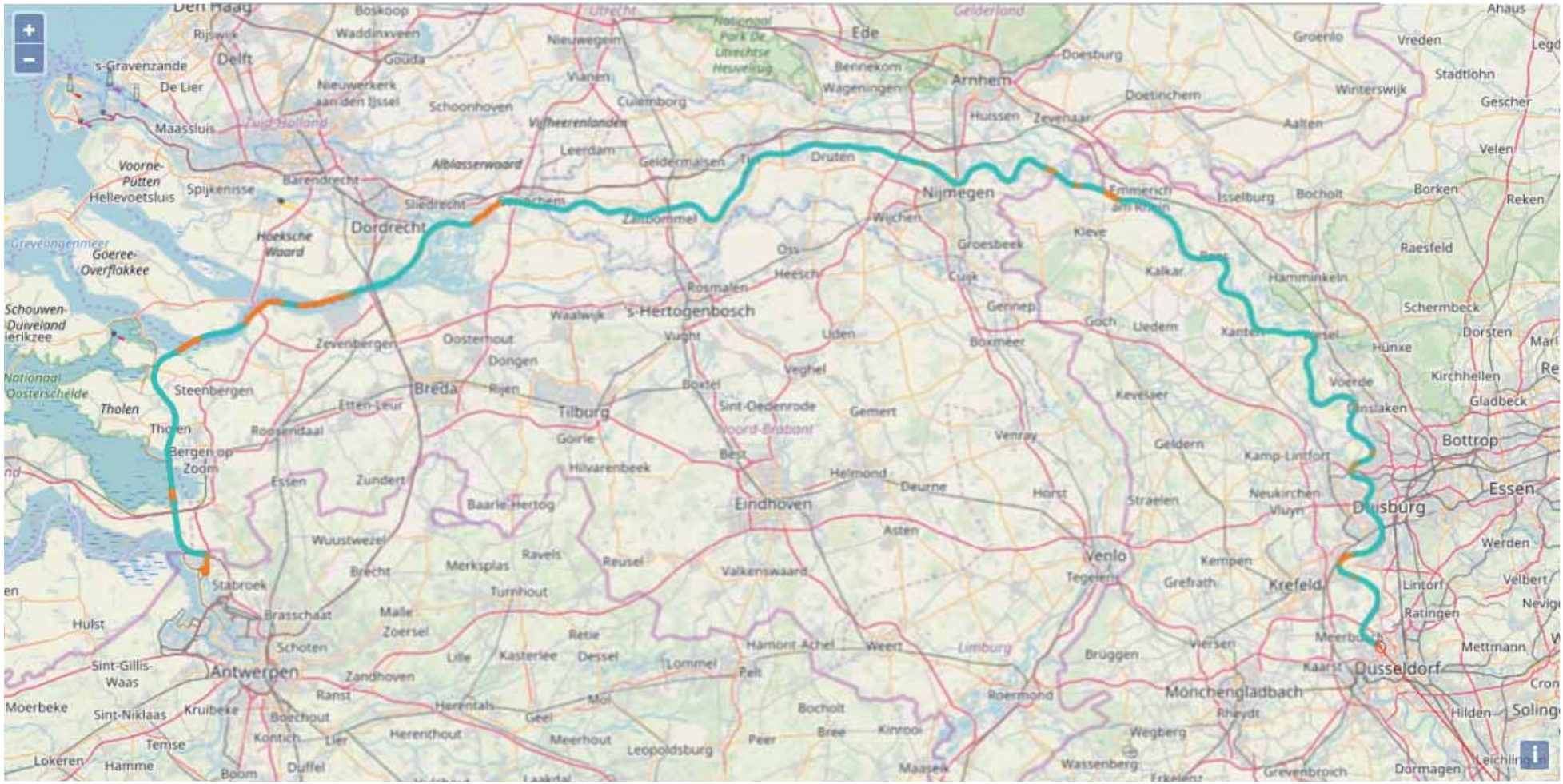
Düsseldorf → Antwerp

22 hours 51 minutes

81 % of the time navigating automatically

standard deviation from track: 2.3 m

KV El Niño + La Niña



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Levels of Automation

	Level	Designation	Vessel command (steering, propulsion, wheelhouse, ...)	Monitoring of and responding to navigational environment	Fallback performance of dynamic navigation tasks	Remote control
BOATMASTER PERFORMS PART OR ALL OF THE DYNAMIC NAVIGATION TASKS	0	**NO AUTOMATION** the full-time performance by the human boatmaster of all aspects of the dynamic navigation tasks, even when supported by warning or intervention systems *E.g. navigation with support of radar installation*				No
	1	**STEERING ASSISTANCE** the context-specific performance by a steering automation system using certain information about the navigational environment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks *E.g. rate-of-turn regulator* *E.g. trackpilot (track-keeping system for inland vessels along pre-defined guiding lines)*				
	2	**PARTIAL AUTOMATION** the context-specific performance by a navigation automation system of both steering and propulsion using certain information about the navigationalenvironment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks				
SYSTEM PERFORMS THE ENTIRE DYNAMIC NAVIGATION TASKS (WHEN ENGAGED)	3	**CONDITIONAL AUTOMATION** the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks, including collision avoidance, with the expectation that the human boatmaster will be receptive to requests to intervene and to system failures and will respond appropriately				Subject to context specific execution, remote control is possible (vessel command, monitoring of and responding to navigational environment and fallback performance). It may have an influence on crew requirements (number or qualification).
	4	**HIGH AUTOMATION** the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks and fallback performance, without expecting a human boatmaster responding to a request to intervene[3] *E.g. vessel operating on a canal section between two successive locks (environment well known), but the automation system is not able to manage alone the passage through the lock (requiring human intervention)*				
	5	**AUTONOMOUS = FULL AUTOMATION** the sustained and unconditional performance by a navigation automation system of all dynamic navigation tasks and fallback performance, without expecting a human boatmaster responding to a request to intervene				

source: CCNR

Present: Rudder only

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source: CCNR

NOVIMAR: Rudder + engine, SciPPPer: + bow thruster

argonics GmbH

Recent Developments – Control System for NOVIMAR

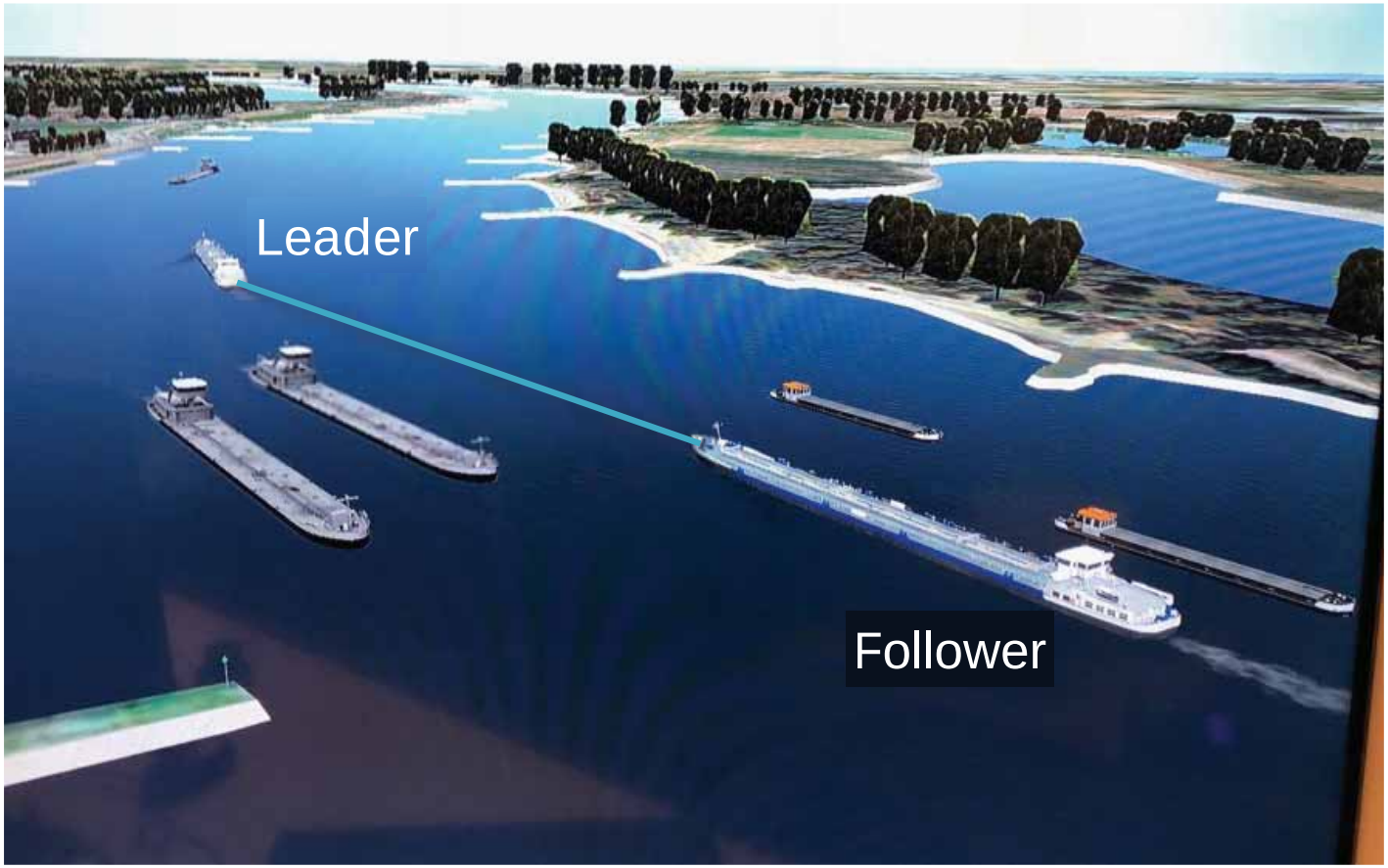
NOVIMAR
VESSELTRAIN

www.novimar.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723009.

Recent Developments – Control System for NOVIMAR

NOVIMAR
VESSELTRAIN



Full-bridge simulator tests at MARIN

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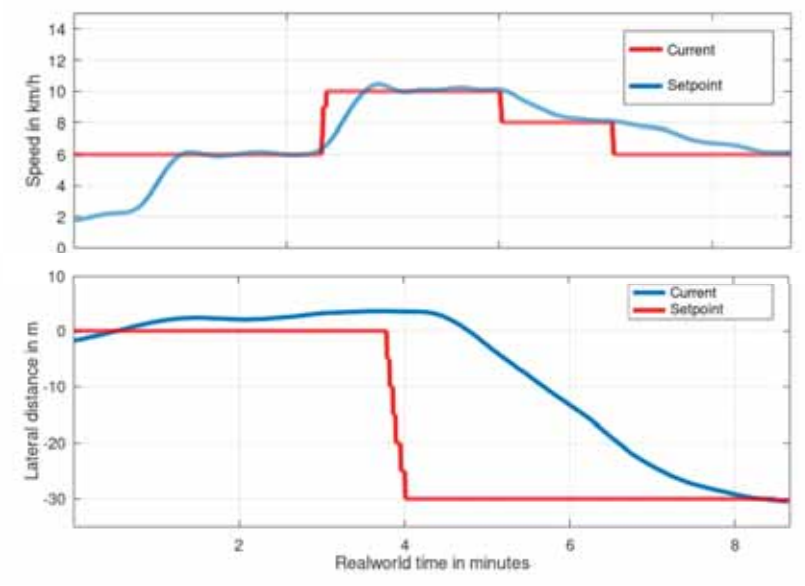
Recent Developments – Control System for NOVIMAR



Tank tests at DST in Duisburg

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Recent Developments – Control System for NOVIMAR

NOVIMAR VESSELTRAIN

DST

argonics GmbH

The project has received funding from the European's Horizon 2020 research and innovation programme (Contract No.: 723009)

Video: Please load external file

www.novimar.eu

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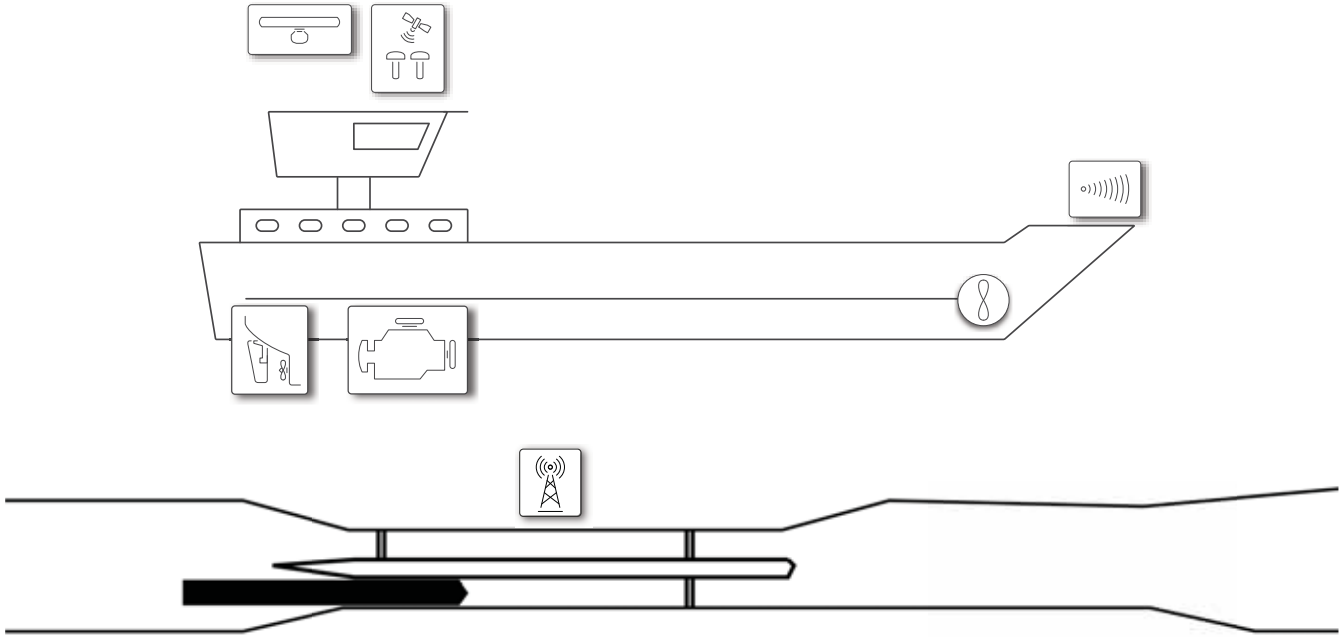
Recent Developments – Control System for SCIPPER

Lock maneuvering assistance system based on PPP and VDES for inland navigation



Alberding

weather AG dock

DLR

in innovative navigation

argonics GmbH

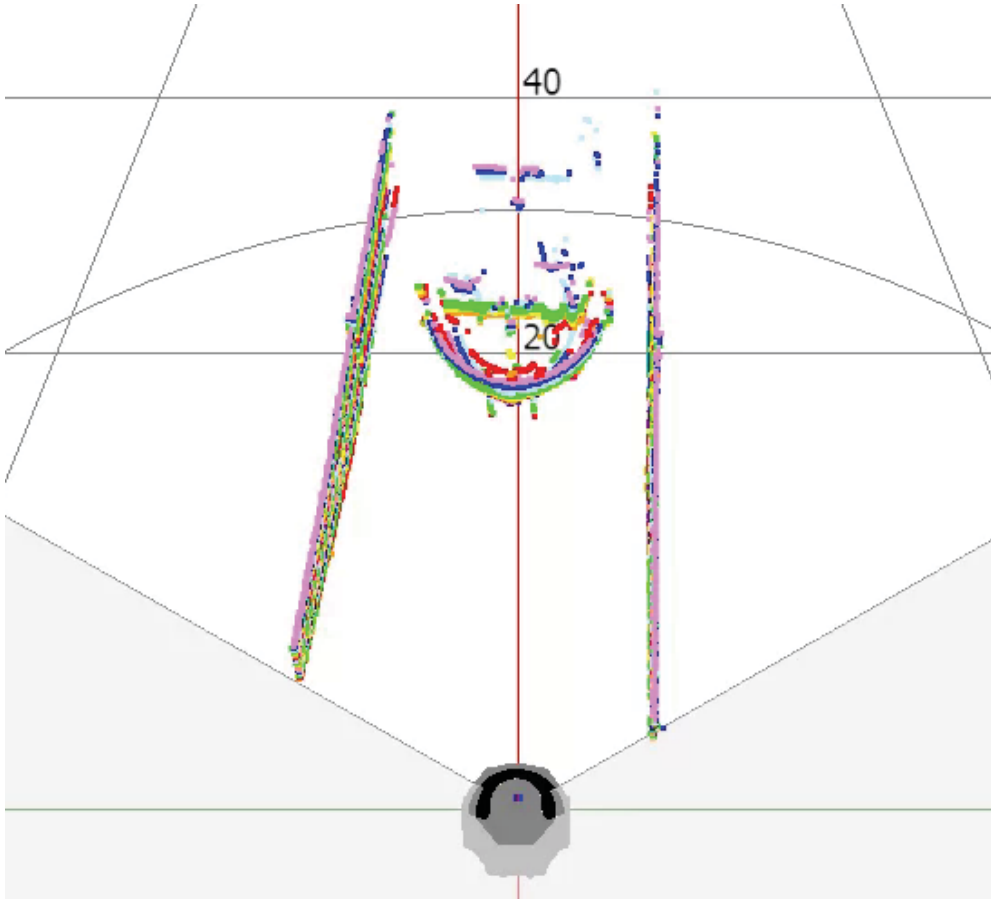
BAW Bundesanstalt für Wasserbau

WSV.de

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Recent Developments – Control System for SCIPPER

Lidar tests in Koblenz



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aufgrund eines Beschlusses des Deutschen Bundestages

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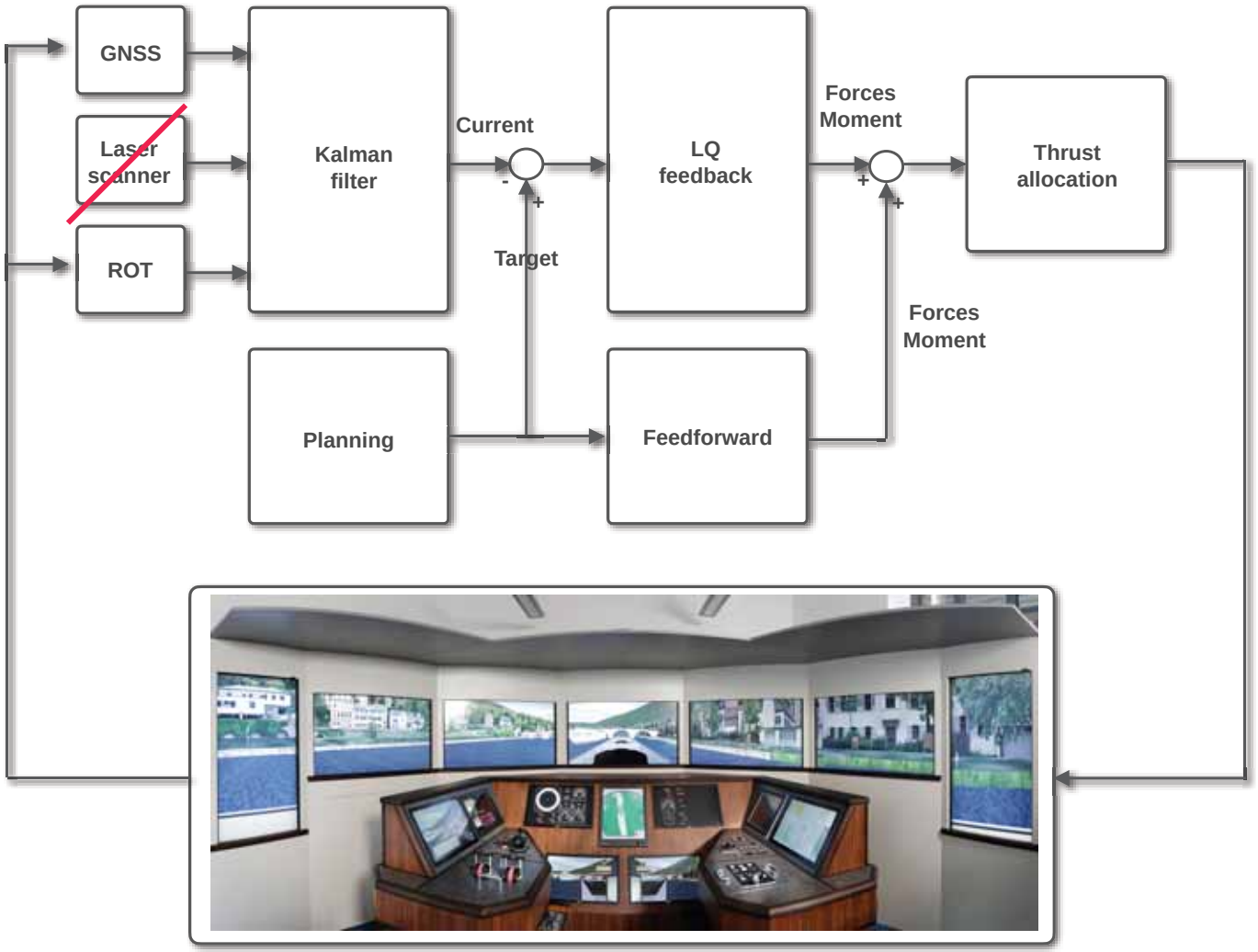
Recent Developments – Control System for SCIPPER

Control system structure for automatic lock entering



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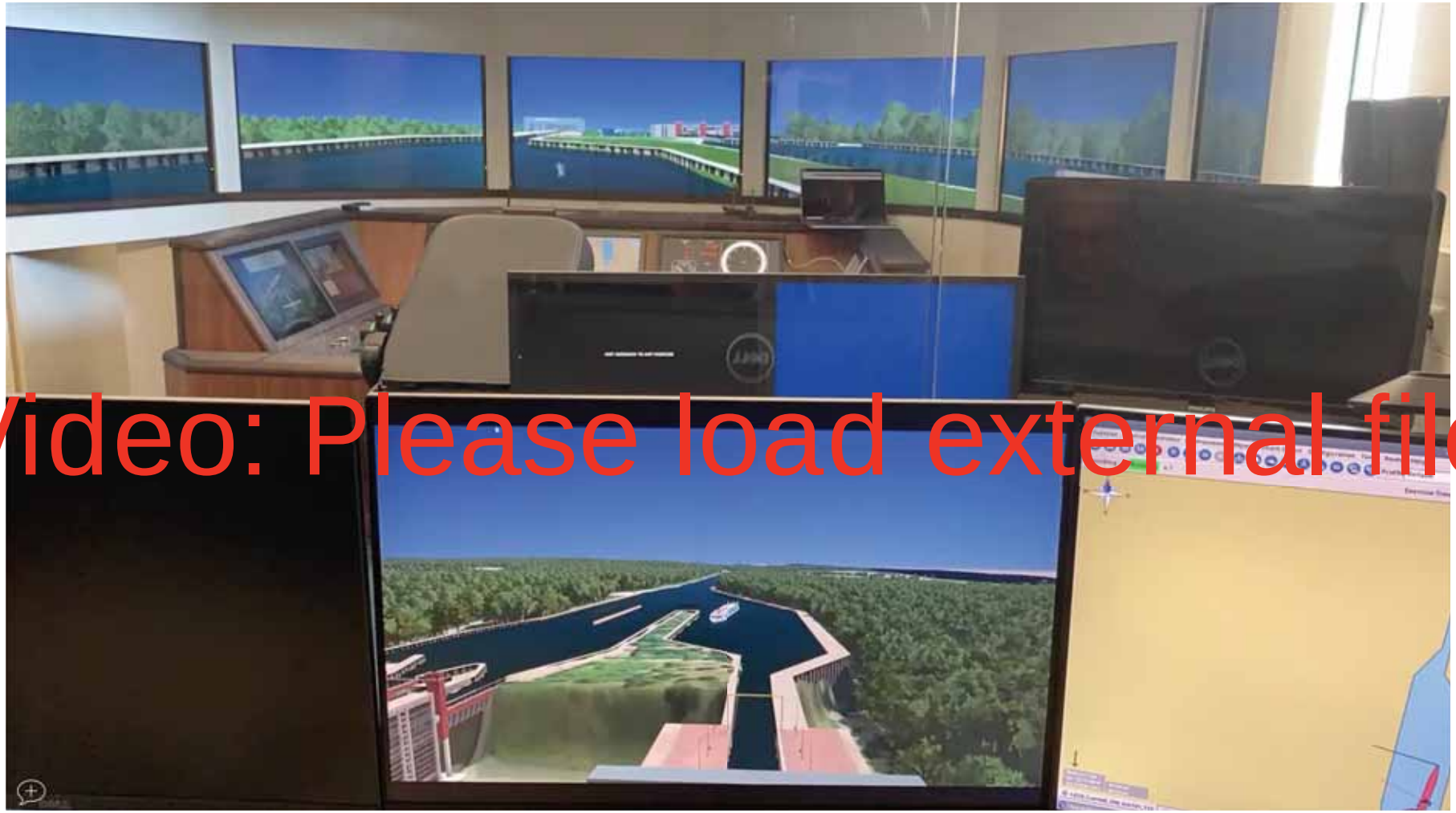
Recent Developments – Control System for SCIPPER



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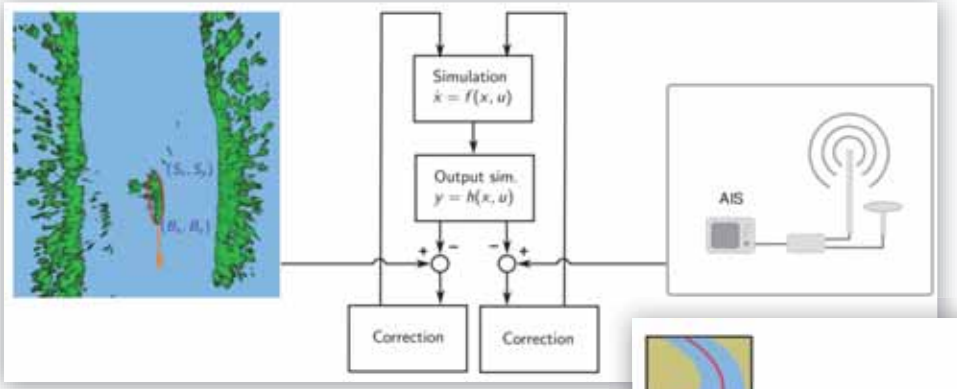
2023

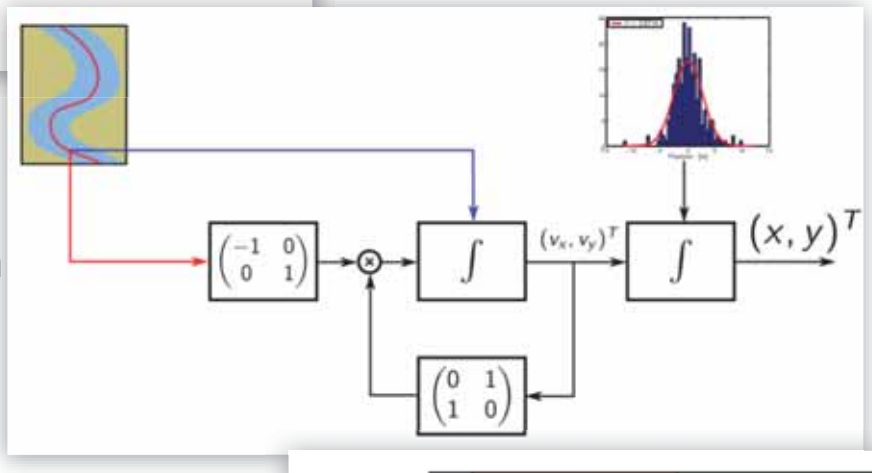
source: CCNR

Automation of Inland Navigation – Collision Avoidance

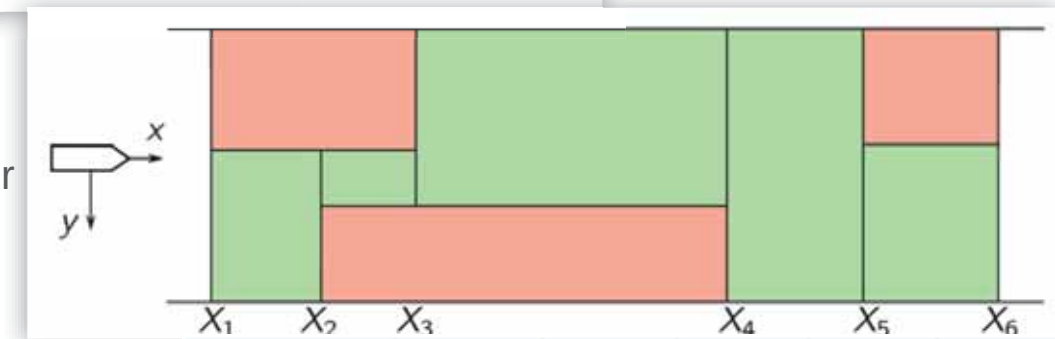


Sensor fusion: radar + AIS

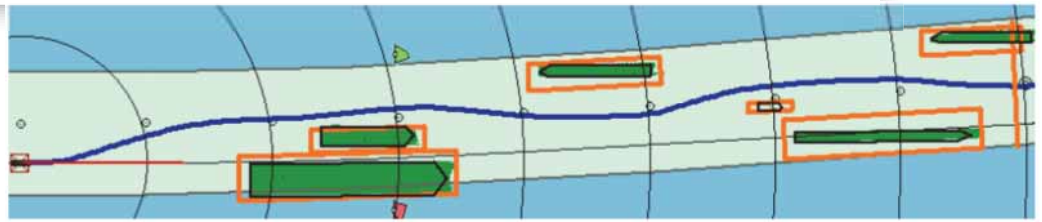
Vessel prediction



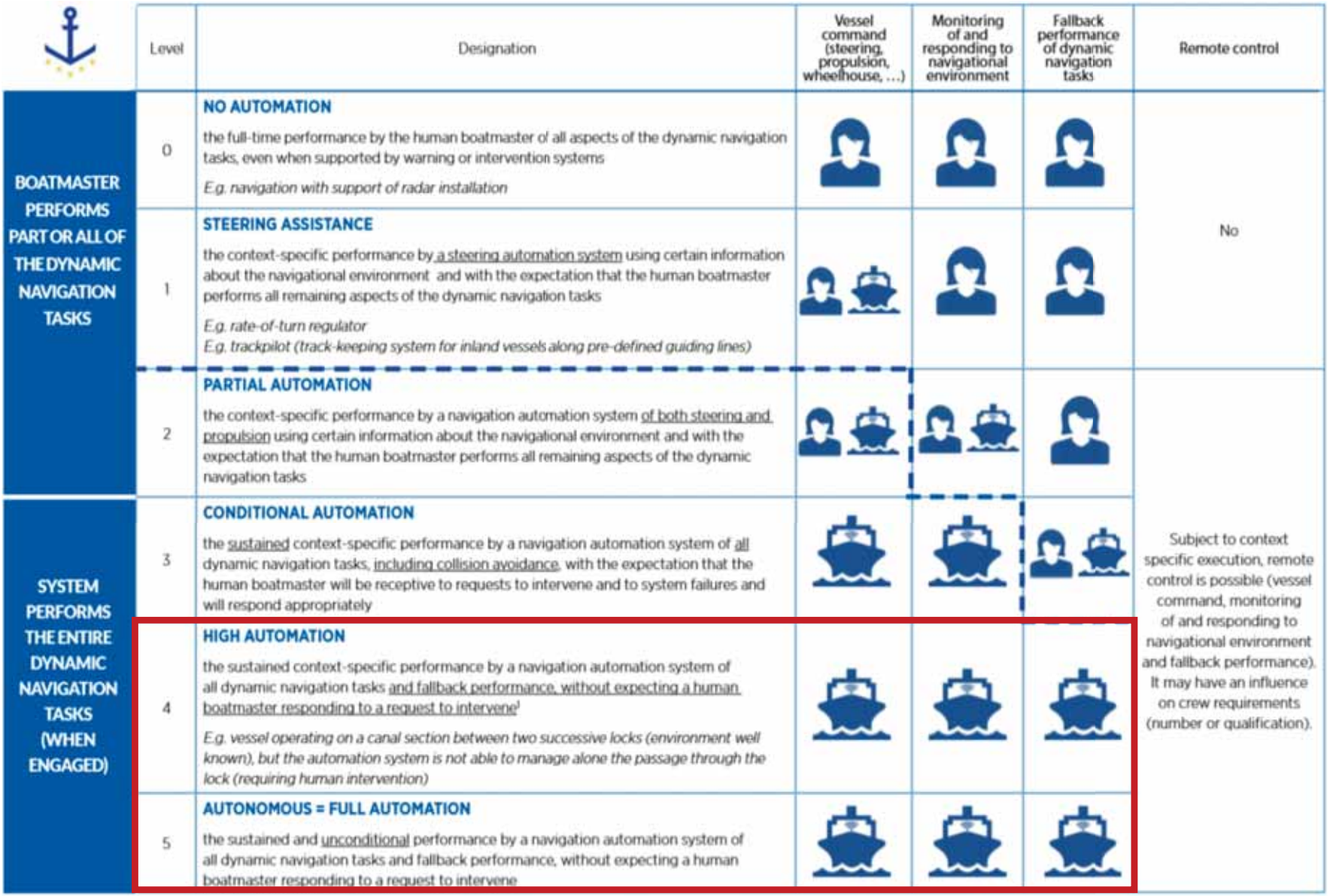
Ranges of encounter



Track calculation



Levels of Automation

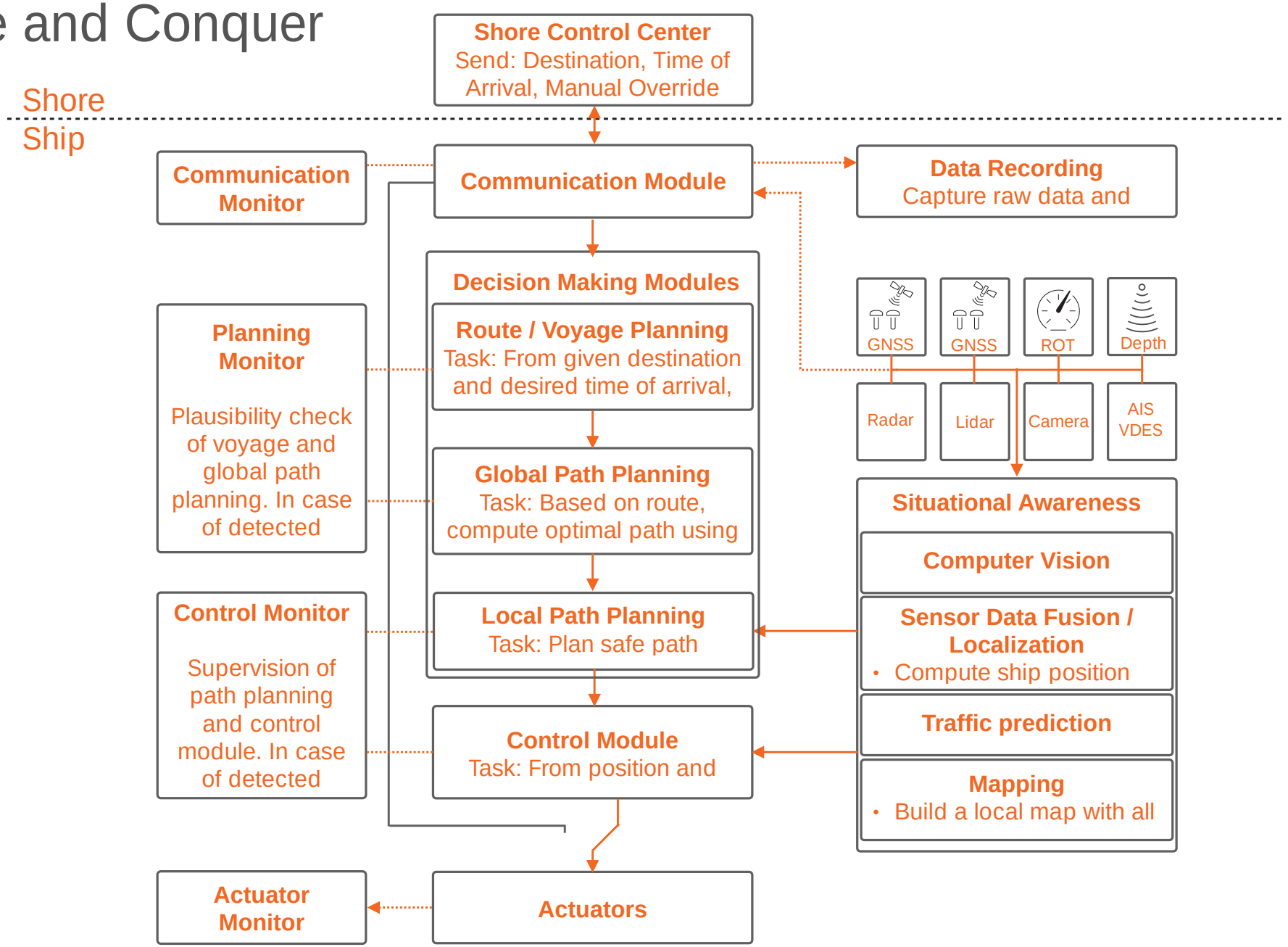


	Level	Designation	Vessel command (steering, propulsion, wheelhouse, ...)	Monitoring of and responding to navigational environment	Fallback performance of dynamic navigation tasks	Remote control
BOATMASTER PERFORMS PART OR ALL OF THE DYNAMIC NAVIGATION TASKS	0	**NO AUTOMATION** the full-time performance by the human boatmaster of all aspects of the dynamic navigation tasks, even when supported by warning or intervention systems *E.g. navigation with support of radar installation*				No
	1	**STEERING ASSISTANCE** the context-specific performance by a steering automation system using certain information about the navigational environment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks *E.g. rate-of-turn regulator* *E.g. trackpilot (track-keeping system for inland vessels along pre-defined guiding lines)*				
	2	**PARTIAL AUTOMATION** the context-specific performance by a navigation automation system of both steering and propulsion using certain information about the navigational environment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks				
SYSTEM PERFORMS THE ENTIRE DYNAMIC NAVIGATION TASKS (WHEN ENGAGED)	3	**CONDITIONAL AUTOMATION** the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks, including collision avoidance, with the expectation that the human boatmaster will be receptive to requests to intervene and to system failures and will respond appropriately				Subject to context specific execution, remote control is possible (vessel command, monitoring of and responding to navigational environment and fallback performance). It may have an influence on crew requirements (number or qualification).
	4	**HIGH AUTOMATION** the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks and fallback performance, without expecting a human boatmaster responding to a request to intervene[1] *E.g. vessel operating on a canal section between two successive locks (environment well known), but the automation system is not able to manage alone the passage through the lock (requiring human intervention)*				
	5	**AUTONOMOUS = FULL AUTOMATION** the sustained and unconditional performance by a navigation automation system of all dynamic navigation tasks and fallback performance, without expecting a human boatmaster responding to a request to intervene				

source: CCNR

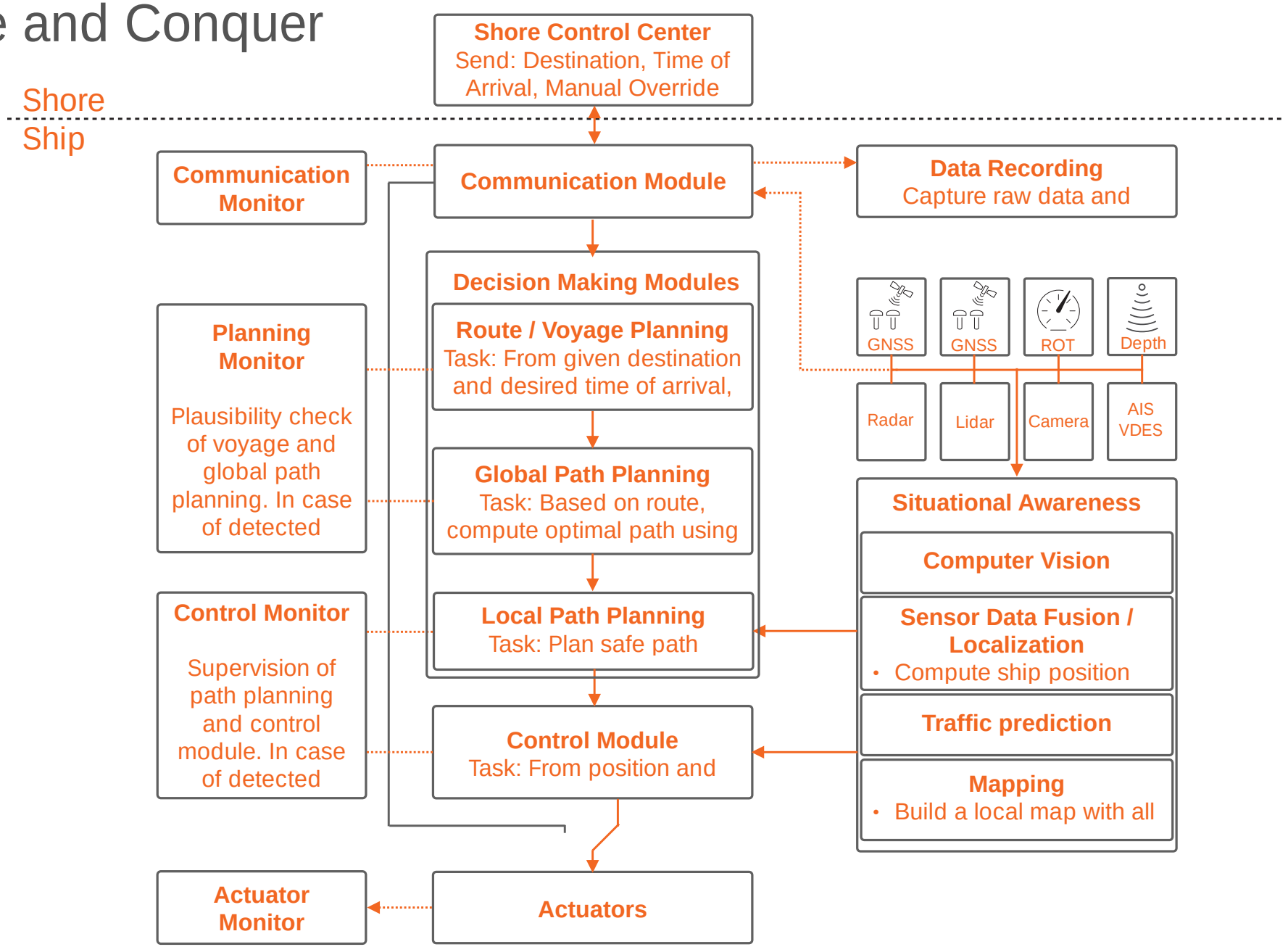
2050?

Divide and Conquer



Artificial Intelligence?

Divide and Conquer



Classical Algorithms + Artificial Intelligence!

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